

U.S. Patent Application Serial No. 10/657,192
Amendment filed July 26, 2005
Reply to OA dated April 27, 2005

AMENDMENTS TO THE CLAIMS:

Claims 1 - 3 and 5 - 9 have been amended as follows. This listing of claims will replace all prior versions, and listings, of claims in the application:

Listing of Claims:

Claim 1. (Currently Amended): A matching box connected to a plasma generator for changing at least one of a phase of current and a phase of voltage of RF power inputted from [[a FR]] an RF source and outputting phase-changed RF power to said plasma generator,

said matching box comprising a variable inductance element, wherein

said variable inductance element includes:

a main winding for determining impedance of said variable inductance element; and

a control winding magnetically coupled to said main winding,

wherein an impedance of said main winding is controlled based on a magnitude of direct current flowing through said control winding, which is in turn based on plasma generation in said plasma generator.

Claim 2 (Currently Amended): A matching box having a high voltage side output terminal connected to a plasma generator, an input terminal connected to [[a FR]] an RF source, said matching box for changing at least one of a phase of current and a phase of voltage of RF power

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inputted into said input terminal and outputting phase-changed RF power to said high voltage side output terminal, said matching box comprising a first variable inductance element, wherein said first variable inductance element comprises:

a first main winding connected to said input terminal and said high voltage side output terminal; and

a first control winding magnetically coupled to said first main winding,

wherein an impedance of said first main winding is controlled based on a magnitude of direct current flowing through said first control winding, which is in turn based on plasma generation in said plasma generation.

Claim 3 (Currently Amended): The matching box according to claim [[1]] 2, further comprising:

a first control power source,

wherein said first control winding is supplied with a current from said first control power source.

Claim 4 (Original): The matching box according to claim 3, wherein said first control power source is connected to a first control circuit, and a signal inputted from said first control circuit changes the magnitude of current outputted to said first control winding.

Claim 5 (Currently Amended): A matching box comprising:

a high voltage side output terminal connected to a plasma generator;

an input terminal connected to [[a FR]] an RF source;

a ground side output terminal connected to ground voltage, said matching box changing at least one of a phase of current and a phase of voltage of RF power inputted into said input terminal and outputting phase-changed RF power from said high voltage side output terminal; and

a [[second]] variable inductance element, wherein said [[second]] variable inductance element comprises:

a [[second]] main winding connected to said input terminal and said ground side output terminal; and

a [[second]] control winding magnetically coupled to said [[second]] main winding,

wherein said [[second]] main winding is controlled based on a magnitude of direct current flowing through said [[second]] control winding, which is in turn based on plasma generation in said plasma generation.

Claim 6 (Currently Amended): The matching box according to claim 5, wherein said matching box has a [[second]] control power source, and current from said [[second]] control power source flows through said [[second]] control winding.

Claim 7 (Currently Amended): The matching box according to claim 6, wherein said [[second]] control power source is connected to a [[second]] control circuit, and a signal inputted from said [[second]] control circuit changes the magnitude of current outputted to said [[second]] control winding.

Claim 8. (Currently Amended): A matching box according to claim 2, further comprising:
a high voltage side output terminal connected to a plasma generator;
an input terminal connected to [[a FR]] an RF source;
a ground side output terminal connected to ground voltage, said matching box changing a phase of current and/or a phase of voltage of RF power inputted into said input terminal and outputting phase-changed RF power from said high voltage side output terminal; and
a second variable inductance element, wherein said second variable inductance element comprises:
a second main winding connected to said input terminal and said ground side output terminal;
and
a second control winding magnetically coupled to said second main winding,
wherein said second main winding is controlled based on a magnitude of direct current flowing through said second control winding.

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Claim 9 (Currently Amended): A vacuum apparatus comprising:

a vacuum chamber;

[[a FR]] an RF source;

a matching box having a variable inductance element for electrically controlling impedance;

and

a plasma generator, connected to said RF source via said matching box, for generating plasma by RF voltage outputted from said RF source,

wherein said variable inductance element is connected between said RF source and said plasma generator, wherein inductance of said variable inductance element is controlled based on plasma generation in said plasma generator, and

wherein a target object disposed in said vacuum chamber is subjected to vacuum processing.

Claim 10 (Original): The vacuum apparatus according to claim 9, wherein said variable inductance element further comprises:

a main winding for determining the impedance of said variable inductance element; and

a control winding magnetically coupled to said main winding,

wherein a magnitude of direct current flowing through said control winding controll the impedance of said main winding.

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Claim 11 (Original): The vacuum apparatus according to claim 9, wherein said plasma generator comprises:

an ionization chamber;

a coil wound around said ionization chamber;

a first electrode disposed in an opening of said ionization chamber; and

a second electrode disposed farther from said ionization chamber than said first electrode,

wherein said plasma generator is an ion gun, and gas supplied to said ionization chamber forms plasma in an alternating current field formed by alternating current flowing through said coil, and positive ions extracted from said plasma by said first and second electrodes are released into said vacuum chamber.

Claim 12 (Original): The vacuum apparatus according to claim 10, further comprising an electron generator for emitting electrons,

wherein when plasma is regenerated due to disappearance of said plasma, a voltage higher than that of said vacuum chamber is applied to said second electrode in order to attract said electrons emitted from said electron generator to said ionization chamber.

Claim 13 (Original): A method of vacuum processing comprising the steps of:

ionizing gas supplied to an ionization chamber by applying an alternating current field to said gas to generate plasma;

applying a positive voltage to a first electrode disposed in the vicinity of an opening of said ionization chamber;

applying negative voltage to a second electrode disposed farther from said ionization chamber than said first electrode;

releasing positive ions into a vacuum chamber, said positive ions being extracted from said plasma by an electric field formed by said first and second electrodes,

releasing electrons from an electron generator into said vacuum chamber in order to neutralize a flow of said positive ions by applying said electrons; and

irradiating said neutralized positive ions to a target object disposed inside said vacuum chamber,

wherein when plasma is regenerated due to disappearance of said plasma, said electrons emitted from said electron generator are attracted into said ionization chamber by applying a voltage higher than that of said vacuum chamber to said second electrode.

Claim 14 (New): The matching box according to claim 1, wherein an impedance between said plasma generator and said RF source in said matching box becomes smaller when said plasma disappears compared to when said plasma is maintained.